

WHAT IS CLAIMED IS:

1. A device for hemodialysis, comprising:
 - a cylindrical housing having a housing wall;
 - a first cylindrical rotor having a first wall comprising a dialysis membrane, wherein said first cylindrical rotor is disposed coaxially within said housing and adapted to rotate therein, such that a first coaxial gap exists between the dialysis membrane and the housing wall;
 - a second cylindrical rotor having a second wall, wherein said second cylindrical rotor is disposed coaxially within said first cylindrical rotor and adapted to rotate therein, such that a second coaxial gap exists between the first and second walls;
 - a first inlet port in the housing wall for conducting blood into the first coaxial gap and a first outlet port in the housing wall for conducting dialyzed blood out of the first coaxial gap;
 - a second inlet port in said housing for conducting dialysis fluid into the second coaxial gap and a second outlet port in said housing for conducting dialysate out of the second coaxial gap;
 - a first rotational drive means for rotating the first cylindrical rotor within said housing; and
 - a second rotational drive means for rotating the second cylindrical rotor within said housing.
2. The device of Claim 1, wherein the first rotational drive means comprises a spinner magnet mounted to the first cylindrical rotor, and an external rotating magnetic field.
3. The device of Claim 1, wherein the second rotational drive means comprises a spinner magnet mounted to the second cylindrical rotor, and an external rotating magnetic field.
4. The device of Claim 1, wherein the first cylindrical rotor rotates with sufficient speed to create Taylor vorticity in the blood in the first coaxial gap.
5. The device of Claim 1, wherein the second cylindrical rotor rotates with sufficient speed to create Taylor vorticity in the dialysate in the second coaxial gap.
6. A device for hemodialysis, comprising:

a housing having a housing wall;

a first rotor having a first wall comprising a dialysis membrane and defining a first interior, wherein said first rotor is disposed within said housing and is adapted to rotate therein, such that a first gap exists between the dialysis membrane and the housing wall; and

a first rotational drive means for rotating the first rotor within said housing at a speed sufficient to create Taylor vorticity in the first gap.

7. The device of Claim 6, wherein the first rotational drive means comprises a spinner magnet mounted to the first rotor, and an external rotating magnetic field.

8. The device of Claim 6, wherein the first gap has a cross-section having a variable width.

9. The device of Claim 6, wherein the first wall has a generally circular cross-section.

10. The device of Claim 9, wherein the first rotor is disposed coaxially within said housing.

11. The device of Claim 9, wherein the first rotor is not disposed coaxially within said housing.

12. The device of Claim 6, further comprising:

a first inlet port in the housing wall for conducting blood into the first gap and a first outlet port in the housing wall for conducting dialyzed blood out of the first gap; and

a second inlet port in the housing for conducting dialysis fluid into the first interior and a second outlet port in the housing for conducting dialysate out of the first interior.

13. The device of Claim 13, further comprising:

a second rotor having a second wall and defining a second interior, wherein said second rotor is disposed within said first interior and is adapted to rotate therein, such that a second gap exists between the first wall and the second wall; and

a second rotational drive means for rotating the second rotor within said first rotor at a speed sufficient to create Taylor vorticity in the second gap.

14. The device of Claim 13, wherein the second inlet port conducts dialysis fluid into the second gap and the second outlet port conduces dialysate out of the second gap.

15. The device of Claim 13, wherein the second wall is impermeable to dialysis fluid.
16. The device of Claim 13, wherein the second rotational drive means comprises a spinner magnet mounted to the second rotor, and an external rotating magnetic field.
17. The device of Claim 13, wherein the second gap has a cross-section having a variable width.
18. The device of Claim 13, wherein the second wall has a generally circular cross-section.
19. The device of Claim 18, wherein the second rotor is disposed coaxially within said first rotor.
20. The device of Claim 18, wherein the second rotor is not disposed coaxially within said first rotor.
21. A system for hemodialysis, comprising:
 - an extraction tube for drawing blood from a patient;
 - a return tube for returning blood to the patient;
 - a hemodialysis device for extracting waste by-products from blood, including:
 - a housing having a housing wall;
 - a first rotor having a first wall comprising a dialysis membrane and defining a first interior, wherein said first rotor is disposed within said housing and is adapted to rotate therein, such that a first gap exists between the dialysis membrane and the housing wall;
 - a first inlet port in the housing wall for conducting the blood into the first gap and a first outlet port in the housing wall for conducting dialyzed blood out of the first gap;
 - a second inlet port in the housing for conducting dialysis fluid into the first interior and a second outlet port in the housing for conducting dialysate out of the first interior; and
 - a first rotational drive means for rotating the first rotor within said housing at a speed sufficient to create Taylor vorticity in the first gap;
 - a separator for extracting plasma water; and
 - a junction at which the plasma water is integrated with the blood.
22. The system of Claim 21, wherein the junction connects to the extraction tube.

23. The system of Claim 21, wherein the junction connects to the return tube.
24. The system of Claim 21, wherein the separator comprises:
- a separator housing having a separator housing wall;
 - a first separator rotor having a first separator wall comprising a separation membrane and defining a first separator interior, wherein said first separator rotor is disposed within said separator housing and is adapted to rotate therein, such that a first separator gap exists between the separation membrane and the separator housing wall;
 - a first separator inlet port in the separator housing wall for conducting a first fluid into the first separator gap and a first separator outlet port in the separator housing wall for conducting the first fluid out of the first separator gap;
 - a second separator outlet port in the separator housing for conducting the plasma water out of the first separator interior; and
 - a first separator rotational drive means for rotating the first separator rotor within said separator housing at a speed sufficient to create Taylor vorticity in the first separator gap.
25. The system of Claim 24, wherein the first fluid is dialysate.
26. A device to facilitate mass transfer from a first fluid, comprising:
- a housing having a housing wall;
 - a rotor having a wall comprising a filtration membrane and defining an interior, wherein said rotor is disposed within said housing and is adapted to rotate therein;
 - a gap between the filtration membrane and the housing wall, wherein the gap has a cross-section having a variable width; and
 - a rotational drive means for rotating the rotor within said housing at a speed sufficient to create Taylor vorticity in the gap.
27. A device to facilitate heat transfer from a first fluid, comprising:
- a housing having a housing wall;
 - a rotor having a wall comprising a membrane and defining an interior, wherein said rotor is disposed within said housing and is adapted to rotate therein;

- a gap between the membrane and the housing wall, wherein the gap has a cross-section having a variable width; and
 - a rotational drive means for rotating the rotor within said housing at a speed sufficient to create Taylor vorticity in the gap.
28. A device for hemodialysis, comprising:
- a housing having a housing wall;
 - a rotor having a wall comprising a dialysis membrane and defining an interior, wherein said rotor is disposed within said housing and is adapted to rotate therein;
 - a gap between the dialysis membrane and the housing wall, wherein the gap has a cross-section having a variable width; and
 - a rotational drive means for rotating the rotor within said housing at a speed sufficient to create Taylor vorticity in the gap.
29. A device to facilitate mass transfer from a first fluid, comprising:
- a housing having a housing wall;
 - a first rotor having a first wall comprising a filtration membrane, wherein said first rotor is disposed within said housing and adapted to rotate therein, such that a first gap exists between the filtration membrane and the housing wall;
 - a second rotor having a second wall, wherein said second rotor is disposed within said first rotor and adapted to rotate therein, such that a second gap exists between the first and second walls;
 - a first inlet port in the housing wall for conducting the first fluid into the first gap and a first outlet port in the housing wall for conducting filtered first fluid out of the first gap;
 - a first rotational drive means for rotating the first rotor within said housing;
- and
- a second rotational drive means for rotating the second rotor within said housing.
30. The device of Claim 29, further comprising:
- a second fluid for receiving mass transferred from the first fluid; and

- a second inlet port in said housing for conducting the second fluid into the second gap and a second outlet port for conducting the second fluid out of the second gap.
31. The device of Claim 29, wherein the first rotor rotates at a speed sufficient to create Taylor vorticity in the first gap.
 32. The device of Claim 29, wherein the second rotor rotates at a speed sufficient to create Taylor vorticity in the second gap.
 33. The device of Claim 29, wherein the second wall comprises a second filtration membrane.
 34. The device of Claim 29, wherein the second wall is impermeable to fluid.
 35. The device of Claim 29, wherein the first gap has a cross-section having a variable width.
 36. The device of Claim 29, wherein the second gap has a cross-section having a variable width.
 37. The device of Claim 29, wherein the first and second walls have generally circular cross-sections.
 38. The device of Claim 37, wherein the first and second rotors are disposed coaxially within said outer housing.
 39. The device of Claim 37, wherein the first and second rotors are not disposed coaxially within said outer housing.
 40. A device to facilitate heat transfer from a first fluid, comprising:
 - a housing having a housing wall;
 - a first rotor having a first wall comprising a membrane, wherein said first rotor is disposed within said housing and adapted to rotate therein, such that a first gap exists between the membrane and the housing wall;
 - a second rotor having a second wall, wherein said second rotor is disposed within said first rotor and adapted to rotate therein, such that a second gap exists between the first and second walls;
 - a first inlet port in the housing wall for conducting the first fluid into the first gap and a first outlet port in the housing wall for conducting heat-exchanged first fluid out of the first gap;

- a first rotational drive means for rotating the first rotor within said housing;
and
a second rotational drive means for rotating the second rotor within said housing.
41. The device of Claim 40, further comprising:
a second fluid for receiving heat transferred from the first fluid; and
a second inlet port in said housing for conducting the second fluid into the second gap and a second outlet port in said housing for conducting the second fluid out of the second gap.
42. The device of Claim 40, wherein the first rotor rotates at a speed sufficient to create Taylor vorticity in the first gap.
43. The device of Claim 40, wherein the second rotor rotates at a speed sufficient to create Taylor vorticity in the second gap.
44. The device of Claim 40, wherein the first gap has a cross-section having a variable width.
45. The device of Claim 40, wherein the second gap has a cross-section having a variable width.
46. The device of Claim 40, wherein the first and second walls have generally circular cross-sections.
47. The device of Claim 46, wherein the first and second rotors are disposed coaxially within said outer housing.
48. The device of Claim 46, wherein the first and second rotors are not disposed coaxially within said outer housing.
49. A method of performing hemodialysis on a patient, comprising:
providing a hemodialysis device configured to create Taylor vorticity;
introducing blood from the patient into the hemodialysis device;
rotating a first rotor within the hemodialysis device to create Taylor vorticity within the blood; and
collecting dialyzed blood from the hemodialysis device for return to the patient.
50. The method of Claim 49, further comprising:

introducing dialysis fluid into the hemodialysis device.

51. The method of Claim 50, further comprising:
 - rotating a second rotor within the hemodialysis device to create Taylor vorticity within the dialysis fluid.
52. The method of Claim 49, further comprising:
 - separating plasma water from waste flowing from the hemodialysis device.
53. The method of Claim 52, wherein the step of collecting dialyzed blood further comprises collecting the plasma water for combining with the dialyzed blood for return to the patient.
54. The method of Claim 52, wherein the step of introducing blood from the patient further comprises introducing the plasma water in combination with blood from the patient.
55. The method of Claim 52, wherein the step of separating further comprises creating Taylor vorticity in the plasma water and waste.
56. A method of performing hemodialysis on a patient, comprising:
 - providing a hemodialysis device having:
 - a housing with a housing wall;
 - a first cylindrical rotor with a first wall comprising a dialysis membrane, wherein said first cylindrical rotor is disposed coaxially within said housing and adapted to rotate therein, such that a first coaxial gap exists between the dialysis membrane and the housing wall;
 - a second cylindrical rotor with a second wall, wherein said second cylindrical rotor is disposed coaxially within said first cylindrical rotor and adapted to rotate therein, such that a second coaxial gap exists between the first and second walls;
 - a first inlet port in the housing wall and a first outlet port in the housing wall;
 - a second inlet port in said housing and a second outlet port in said housing;
 - a first rotational drive means for rotating the first cylindrical rotor within said housing; and

a second rotational drive means for rotating the second cylindrical rotor within said housing;

introducing blood from the patient into the first coaxial gap through the first inlet port;

creating Taylor vorticity within the blood by rotating the first cylindrical rotor using the first rotational drive means;

introducing dialysis fluid into the second coaxial gap through the second inlet port;

creating Taylor vorticity within the dialysis fluid by rotating the second cylindrical rotor using the second rotational drive means;

collecting dialyzed blood from the hemodialysis device through the first outlet port; and

collecting dialysis fluid from the hemodialysis device through the second outlet port.

57. A method of performing mass transfer from a first fluid, comprising:

providing a filtration device having:

a housing with a housing wall;

a first rotor with a first wall comprising a filtration membrane, wherein said first rotor is disposed within said housing and adapted to rotate therein, such that a first gap exists between the filtration membrane and the housing wall;

a second rotor with a second wall, wherein said second rotor is disposed within said first rotor and adapted to rotate therein, such that a second gap exists between the first and second walls;

a first inlet port in the housing wall and a first outlet port in the housing wall;

a first rotational drive means for rotating the first rotor within said housing; and

a second rotational drive means for rotating the second rotor within said housing;

introducing the first fluid into the first gap through the first inlet port;

creating Taylor vorticity within the first fluid by rotating the first rotor using the first rotational drive means;

creating Taylor vorticity by rotating the second rotor using the second rotational drive means;

collecting filtered first fluid from the filtration device through the first outlet port.

58. A method of performing heat transfer from a first fluid, comprising:

providing a filtration device having:

a housing with a housing wall;

a first rotor with a first wall comprising a membrane, wherein said first rotor is disposed within said housing and adapted to rotate therein, such that a first gap exists between the membrane and the housing wall;

a second rotor with a second wall, wherein said second rotor is disposed within said first rotor and adapted to rotate therein, such that a second gap exists between the first and second walls;

a first inlet port in the housing wall and a first outlet port in the housing wall;

a first rotational drive means for rotating the first rotor within said housing; and

a second rotational drive means for rotating the second rotor within said housing;

introducing the first fluid into the first gap through the first inlet port;

creating Taylor vorticity within the first fluid by rotating the first rotor using the first rotational drive means;

creating Taylor vorticity by rotating the second rotor using the second rotational drive means;

collecting heat-exchanged first fluid from the filtration device through the first outlet port.

59. A method of increasing mass transfer across a semi-permeable barrier, comprising:

creating vorticity on both sides of the barrier.

60. The method of Claim 59, wherein creating vorticity further comprises creating Taylor vorticity on both sides of the barrier.